but I've never seen a worse case of workmanship. The work did not have the proper supervision, and the contractor would not carry the responsibility.

Until road supervisors have a knowledge of the properties of road materials, and a lot of experience, they will have to depend upon those men who have knowledge of materials and are making this Road School possible.

ROAD OIL AND POWDERED ASPHALT

George H. Morrow,
Howard County Surveyor and City Engineer,
Kokomo

Powdered asphalt and road oil were first used in Howard County on what is known as the Touby Pike. The road was originally constructed of gravel and crushed stone and compacted by traffic. At subsequent intervals additional material, usually crushed stone, was added as maintenance required. About four years ago traffic had increased to the point that it was deemed advisable to do something more than add stone, in order to prevent expensive upkeep and to eliminate dust. It was therefore decided to surface-treat the road, using road oil mulch, cutback asphalt, and tar surface treatments on different sections. The different applications relieved the situation for a time, but it was soon apparent that something more substantial would have to be undertaken. It was then decided to improve the road by increasing its thickness and at the same time building a smooth, firm, and durable wearing-surface.

In order to conserve the available funds as much as possible, local gravel in close proximity to the road was selected. The sieve analysis of the gravel showed that there was an insufficient amount of coarse material to insure proper stability; so a certain percentage of crushed stone (size No. 8) was obtained from the local stone quarry at Kokomo and added to the gravel.

The bituminous material selected to cement and hold the aggregate together was composed of two kinds of asphalt, which, when combined together in the mixing process, produced an asphaltic cement of 250+ penetration. The decision to use that type of cement was made in order to compare its use with other kinds, namely, cutback asphalt, emulsified asphalt, road oil, and tars of different characteristics. It was thought that it might be possible to coat each piece of aggregate more thoroughly and uniformly with a film of asphaltic cement, and with less labor and construction cost, by using powder and flux oil than by using one of the above-mentioned cements.

In the construction of the Touby Pike, the amount of the flux oil was about 5 per cent of the weight of the aggregate, and the amount of powdered asphalt was about 25 per cent of the weight of the flux oil used. The use of the two kinds of bituminous materials, blended together on the aggregate, appeared to have several advantages. It permitted a wider range in the grading of aggregates. Crushed stone, crushed gravel, crushed slag, gravel, sand, limestone dust, and combinations of those materials might be used successfully. While the scope of comparisons on this job was too limited to check results to the point that definite conclusions might be drawn, it appeared that in mixing the aggregates with the oil and powder a uniformly-coated aggregate was obtained more speedily than with an asphaltic cement compound prior to its application on the road.

The flux oil was first applied to the road by means of a pressure distributor, and each particle of aggregate was coated with it. Then powder was added to produce the asphaltic cement of the penetration desired. The process was somewhat similar to that used in the early sheet asphalt pavements in this country. Hard Trinidad asphalt was combined with a flux oil of approximately 250 viscosity to produce an asphaltic cement of approximately 50 penetration, the advantage being that the changes of penetration could be made on the job at the direction of the engineer.

The first work on the Touby Pike was patching all holes and depressions with a premixed asphaltic concrete, bringing the road surface to a uniform contour and cross-section.

The aggregate for the road consisted of a combination of one-third crushed stone and two-thirds bank-run gravel. The gravel, from a local pit, was put through a crusher so that all material passed a one-inch screen. This gravel was spread on the road through a spreader box in order to produce a uniform windrow. Crushed stone (size No. 8) was then added by means of the spreader box in an amount necessary to make a total thickness of 1½ inches. The two aggregates were thoroughly mixed by blading.

The windrow was then placed on one side of the roadway and the opposite half was primed with .15 gallon of flux oil per square yard. Since the surface was built on an old bituminous base, very little time was necessary for penetration before the windrow was moved onto the treated surface and the other half of the road was primed.

The windrow of aggregate was spread in the center of the roadway to a width slightly greater than the reach of the spreader bars of the distributor. Flux oil was applied in two applications of 0.50 and 0.20 gallons per square yard, with mixing between applications continued until the aggregate was thoroughly coated with flux oil and showed a uniform color. The oiled aggregate was spread on the center of the

roadway to a width slightly greater than the powdered asphalt spreader, and powdered asphalt was applied at the rate of one-half pound per square yard. Alternate mixing and applying powdered asphalt in one-half pound amounts per square yard was continued until three applications were made. The mixing was again resumed until a visual inspection showed the mixture to be thoroughly completed and uniform in color.

The bituminous mixture was spread to grade and cross-section, using both a grader and a motor patrol. A small amount of covering aggregate, approximately 15 pounds per square yard, was applied, tailgating it from trucks, and the surface was rolled with a 10-ton, three-wheeled roller.

Traffic was not kept entirely off the road during construction. However, signs were erected at the end of each day's work.

The cost of construction of a 1½-inch compacted thickness, including flux oil, powdered asphalt, gravel, stone, blading, rolling, and finishing, amounted to $0.22 per square yard. The cost of the bituminous cement was approximately the same as for other types of bituminous construction of like thickness and aggregate grading. Possibly the combining of aggregates and bituminous cement was accomplished in less time and with less expense by use of flux oil and powdered asphalt than might have been the case had other types of bituminous cements been employed.

The road has now been in use approximately six months and gives every evidence of becoming one of the best bituminous roads in Howard County.

TAR ROADS

Nate E. Weekly,
Randolph County Road Supervisor,
Winchester

The most important factor in building any road is drainage. The right-of-way should be at least 40 feet with adequate side-ditches. The roadway should be 24 feet with culverts and bridges widened to the same width. It is also an important factor to have the curves properly banked. The crown of the road is another factor, and a very important one. I would recommend ¼-inch to the foot; all that is necessary is sufficient crown to insure proper drainage.

Of all the road hazards, poor visibility is the most serious. The small, sharp hills or knolls, all too numerous on our roads, must be cut down to a gradual incline to allow visibility of at least 600 feet, and sharp turns and jogs must be eliminated.

Sufficient time should elapse after the grade has been completed for shoulders to settle, and grade or base to become